

ART. XXXIX.—*Notes on the Tidal Phenomena of Hobson's Bay, as affecting the discharge of Flood Waters from the River Yarra.* By THOMAS E. RAWLINSON. C.E.

[Read Oct. 31st, 1864.]

The importance of the River Yarra to the City of Melbourne, taken in connection with the large and yearly increasing value of the interests which have arisen on its banks, and the prospective value of the low lands liable to flood between Melbourne and the Bay, renders the question of dealing with the flood waters to which it is subject one of no ordinary importance.

The late frequent and disastrous floods, have further given the subject an immediately practical character.

Various plans have been proposed from time to time for relieving the river in time of flood, nearly all of which (indeed all the plans of a practical character) contemplate the locality of Hobson's Bay as the only available site for the discharge of the surplus waters, and it is in reference to this part of the question that I propose to offer a few remarks in connection with the tidal diagrams submitted. The Bay being the only available outlet for drainage purposes, any influence acting upon its waters, tending to elevate or depress their general level, must as a consequence have a reflex influence upon the drainage, by diminishing or increasing the available fall for the waters, and proportionately reduce or enlarge the discharging power of the water courses, and it is proposed in this paper to illustrate the tidal phenomena in the Bay, having such tendency to diminish or increase the drainage power of the river.

The fact of unusual high tides in Hobson's Bay, and their retention at an unusual height for lengthened periods, is not unknown, and from their being usually accompanied by south-westerly winds, the high tides are attributed to such winds.

The object of this paper and accompanying diagrams is to show that the winds are but a secondary cause, and may perhaps be more correctly termed a consequence or result of the prime cause, namely, atmospheric disturbance, of which the barometer is the index; the heaping up of the waters, or their depression, independent of the diurnal tides, being but the reflex of the atmospheric wave, acting upon the surface of the waters.

In a limited area like Port Phillip Gulf, communicating by a comparatively narrow entrance with the ocean through Bass's Straits, I scarcely hoped to find such a decided result as the diagram affords of the influence of atmospheric pressure on the waters, independent of the wind currents.

For the illustration of the question, I have selected from the 30th October to the 25th December, 1863, this period being inclusive of the time of the unusual and disastrous floods of last year.

The diagrams are constructed as follows :—

The tidal range is given hourly in time, and the vertical rise and fall in feet.

The barometer and wind readings are for the hours of 6 and 9 a.m., and 3 and 9 p.m., of each day. The force of the wind is indicated by vertical black lines, according to Glaisher's system of notation, the direction being shown by red arrows. Down is a north wind, upwards is south, to the right is a west, and to the left an east wind, whilst intermediate points are shown by angles of corresponding inclination to the chief points of the compass.

The age of the moon is shown by the black circles under the tidal diagram.

The reading of the attached thermometer was taken, but it is not used in connection with this paper, owing to its bearing on the question being far too remote to be entitled to notice.

By reference to the 30th of October on the diagram, the influence of a powerful north wind is evinced in counter-acting the effect of a low barometer, whilst, on the other hand, a west-south-west and south-south-west wind of force, drives up the waters even against a rising barometer, and the lessening lunar influence of the moon as she approaches her first quarter. The foregoing is an exceptional contrast to the usual result in showing the power of the wind, but it serves as a foil subsequently, to exhibit in a stronger light the overruling influence of the atmospheric column, as against the atmospheric current. The moderate breezes from the south-south-west and the south-west, on the 3rd November, are insufficient to force up the tides under the combined influence of high barometric pressure, and the low influence of the moon in her first quarter; during the three succeeding days northerly and north-east winds, in some instances of considerable strength, are sufficient to nullify the slight fall in the barometer from the period of maximum rise on

the 3rd November. On the 10th and 11th November, although powerful winds blew on the 10th from the south-west, they were not sufficient to force the waters up under the pressure of a barometer at from 29·90 to 30·00 inches, even with the strong lunar influence of a new moon; but a remarkable influence of the wind acting with the barometer, is shown in the fall of the ebb tide on the evening of the 11th, under a sudden change of wind from south by west to north-west.

The same influences as above enumerated may be perceived in a moderate form until, on the 16th and 17th November, a sudden fall of the barometer and high gales from the west-north-west, veering round by west to west-south-west, drive up the waters to an unusual height, although the moon had fallen to her last quarter.

The gradual rise of the barometer, from the 18th to the 20th, again forces down the waters, although the winds are from a quarter tending to keep them high.

On the 22nd, a moderate fall of the barometer forces up the water against a northern gentle breeze, whilst towards midnight a gale from the south-west is unable to keep up the tides under a rising barometer.

From the 26th to the 30th, a high barometer again shews its influence in depressing the waters, in the face of continuous breezes or gentle winds from the south, south-west, and south-east.

From the 2nd to the 9th December, the same influences are felt of a high barometer keeping down the waters in the face of breezes from the west, round by south to south-east, until, on the 10th, a barometric fall of $\cdot 25$ - 100 ths lifts the waters upwards of six inches.

The maximum of effect is shown on the 14th of December with the barometer at 28·90, and a gale of wind from the south-west blowing with a force of ten, being equal to 25lbs. pressure to the superficial foot, during which time the waters are driven up two and a half feet higher than the ordinary range of flood tide. On the 14th and 15th, the midday ebb-tides remain in one case twelve inches, and in the other eighteen inches, higher than the ordinary level of preceding flood-tides, whilst the midnight ebb-tide of the 14th did not fall below the level of ordinary flood-tides, and the midnight ebb of the 15th fell only a few inches below the same level.

The diagram for the 14th and 15th of December is remarkable for showing, under the combined influence of

atmospheric pressure and wind currents from the south-west, a continuous heaping up of the waters of the Bay for a period of forty-eight hours, nearly three feet above their ordinary level. Of this result, about two feet is due to the atmospheric pressure alone, the rest being assumed to be due to the heavy gale blowing from the south-west.

The continuance of gales of wind from the west-south-west and south-west, ending in the moderate breezes of the 18th from the same quarters, to some extent checked the beneficial influence of a rising barometer, until, on the 20th of December, the maximum rise again resulted in a maximum fall of the water level.

From the 20th to the 25th of December, a slight fall in the barometer, accompanied by breezes from the south and south-west, slightly elevates the waters as before.

The singular oscillation on the face of the tidal wave on the night of the 23rd of December,* appears to be owing to some inequality of force and direction of the north-east gale, before and after 9 p.m. This inequality I think probable because of the wind having at 3 p.m. been blowing stiffly from the opposite quarter, to which point it had again veered at 6 a.m. on the 24th, from which point, with slight variation, it continued to blow during the remainder of the 24th of December. The slight fall of the barometer may also have had an influence between the gusts of wind.

From the facts narrated in this paper and shown on the diagram, it will be readily understood that the capacity of the river Yarra for discharging its surplus waters is very materially affected by the atmospheric pressure and winds acting upon the waters of the Bay, and that, in the absence of a sufficient fall, the low lying lands around the city and mouth of the Yarra cannot be effectually drained by ordinary channels at all times.

Under ordinary circumstances the mean tide level of the Yarra, opposite to the Custom House, is nearly twenty-six inches higher than the mean tide level at Williamstown. This difference gives about $3\frac{3}{4}$ inches or $\cdot 31$ of a foot fall per mile.

On the 14th and 15th of December, the waters of the Bay were continuously heaped up for a period of forty-eight hours to nearly three feet above the ordinary level of the tides, and the ebb-tide was retained to a yet greater difference

* Note.—Not shewn in reduced diagram.

of height, consequently, even if there had been no flood-waters from above, there must have been a flood (or unusual tide) in the Yarra from the flow of waters up the river meeting and checking the ordinary outflow of the river waters; but when, in addition to the ordinary river discharge, there is the extra drainage due to unusual rain fall and consequent heavy floods, the submerging of the low lying lands becomes a matter of course.

The obstruction in the river, from the falls and the several bridges opposite Melbourne, aggravates the mischief. Even the iron bridge at Church-street, Richmond, is insufficient to pass the flood-waters efficiently, as shown by the thorough scouring away of the carriage road under the bridge. The result, in the case of the Church-street Bridge, is strong evidence of the very large sectional area requisite to discharge the flood-waters of the river, and that it will be unwise, under any circumstances, to construct any bridge lower down of a less span or water way than the Church-street Bridge. Nor do I think it will be wise under any circumstances to reconstruct any dams or weirs in the river between Dight's Mills and the mouth of the river, for they will act in each case as serious obstructions to the free flow of the flood waters.

After a full consideration of the question, taken in connection with the tidal phenomena of the Bay, I believe that effectual means cannot be adopted to permanently benefit the low-lying lands, which do not provide for embanking and raising such lands, as the most prominent feature of the scheme.

The report of the Commission appointed some months back to inquire into the subject, appears to me to embody nearly all that can be said on the subject, even to the proposed point of discharge into the Bay. To one part of the report only do I take exception, and that is, the proposal to reconstruct stone weirs across the river above Prince's Bridge. Such weirs would merely change the locality of a portion of the evil, instead of remedying it; and I submit that the expense involved in the construction of such works, would be more beneficial if employed in buying up the vested interests, which it is one ostensible object of the weir to conserve, namely, the fellmongers and other offensive establishments situate on the Upper Yarra.

The construction of the weirs can scarcely be deemed an integral portion of the scheme, and may have been made in

compliance with the strict letter of instructions to consider the question so as to conserve existing interests ; but I would suggest that it is a fair subject for the consideration of the House when voting supplies for the work.

The retention of the present entrance of the Yarra as the mouth of discharge, is, I think, a sound and wise discretion, for many reasons.

A flood channel entering the Bay at or near to Sandridge, would be subject to many disadvantages, from which the entrance of the River Yarra is free. For instance, near to Sandridge, the outlet would be at a place where the waters of the Bay would be driven to the highest level under the influence of the prevailing winds ; and, from the drift and making of the foreshore, it would be very expensive to maintain open. Even if dredging were available, it would necessitate a double cost for two entrances, in lieu of the one which is now available.

By using the entrance of the Yarra as at present, we merely avail ourselves of one which has been formed under the influence of natural laws, and to maintain which we have but to assist natural causes which are at present existing and in operation. The discharge along the Williamstown shore is under the lee of Point Gellibrand, where the water-level would be the lowest ; and, as a further reason, apart from the current caused along shore by the entrance of the River Yarra at this point, there would be a natural current due to the waters of the Bay being heaped up and driven along the St. Kilda and Sandridge shores by the prevailing gales, and their subsequent escape round by Williamstown and Point Gellibrand.

In the case of a new entrance near to Sandridge, the scouring powers of the discharge waters would be intermittent ; and the above influences, which are favourable to the discharge by the River Yarra mouth, would in every case be the reverse at or near to Sandridge. The adverse influences of the latter are, I believe, much more than sufficient to counterbalance any contemplated saving or advantage in shortness of length and economy in first cost.

The length of canal, and amount of materials to be removed, in the proposal for cutting a new channel from the Queen's Wharf to the entrance of the Yarra, is, in my opinion, scarcely a matter to be regretted, seeing the advantageous use to which the materials can be put in reclaiming

the now comparatively worthless low-lying lands bordering on the Yarra Yarra River.

In preparing this paper and accompanying diagrams, I have been and am much indebted to the kind courtesy of Commander Cox, and the Government astronomer, Mr. Ellery, for the use of the tide and meteorological registers necessary for the compilation of the facts put forward, and take this opportunity of tendering my thanks for the same.

Melbourne, 10th October, 1864.

ART. XL.—*Abel's Fuses and Wheatstone's Exploder.* By
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[Read 18th July, 1864.]

Mr. Ellery (the Government Astronomer) exhibited some of Abel's patent fuses, with an instrument called "Wheatstone's Exploder," together forming a most convenient and powerful means of firing gunpowder by electricity.

Mr. Ellery described the exploder, which is in fact a portable magneto-electric apparatus, as consisting of a set of compound permanent magnets, arranged around a cube, armed with electro-magnetic coils, in front of the poles of which, soft iron armatures could be made to revolve rapidly by turning a handle, giving rise to a pretty powerful induced electric current in the fuse covering wire of the coil; which, by means of suitable connections, could be conducted to considerable distances through properly insulated wire. The whole apparatus was conveniently enclosed in a mahogany case, 8 or 9 inches square, and weighed about 30 pounds.

The fuses exhibited were of two kinds. The ones for firing guns were very similar in appearance to the ordinary friction tube, with the exception that to one end was attached a small knob of beech wood, perforated with two holes, which were copper-lined and served to hold the connecting wires when ready for firing. The other fuses were adapted to blasting purposes, and consisted of a small wooden cartridge filled with powder, to which was attached a pair of insulated wires about two feet long, with which the connecting wires had to be joined when used. The principal point of interest in these fuses was the use of a peculiar composition, very susceptible of ignition by the slightest electric spark. This composition was placed in contact with the two